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PROJECT REPORT

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Progress Report: _____ Final Report: x Project Number: 1072

Small-Scale: _____ Large-Scale: x Funding Year: 1988-89

Transfer Grant: x (Priority: m /) OISE: _____

New: ✓ Continuing: _____ Terminated: x Re-funded: _____

Project Title: Toward a Taxonomy of Possible Computer Effects in Elementary Classrooms

Investigator(s): R.G. Ragsdale & Brian Durrell

Budget Unit: MECA Date Rec'd in F&SR: JL 4/89

ABSTRACT

For large-scale projects, please provide in the space below an abstract of not more than 300 words, single-spaced, written in a language that may be understood by the informed layperson. For small-scale projects, an abstract per se may not be appropriate, and the report itself may be started below.

The project "Toward a Taxonomy of Possible Computer Effects in Elementary Classrooms" was located in an elementary school in a local Roman Catholic Separate School Board. A minimum of three and a maximum of six ICON computers had been placed in each classroom of the school by the School Board. Our research interest was in documenting changes in classroom activity (teacher and student activity) or changes in school functioning which occurred subsequent to the computer application. We were intent on both the expected outcomes of the Board-initiated pilot project at the school as well as the unanticipated side-effects of computer use in the school.

The methodology of the project was primarily naturalistic. Ten classrooms (grade levels Senior Kindergarten to Grade 8) were observed for half a day each week during the school year, and four classrooms were observed intensively over a 20 day period. Observers also attended Board computer meetings and school- based Computer Committee meetings, seminars and software demonstrations. Interviews were conducted with students in primary, junior and intermediate grade levels and with all the teachers who had agreed to observations in their classrooms. Documents were collected from all aspects of the school and included hard copy produced by the students from computer activity, newsletters from the school to the parents, staff memorandums, agendas and minutes from school and Board meetings.

Several papers were presented at conferences and the principal investigators gave presentations of project findings to the school staff. The research process and the initial project findings were incorporated into university courses taught by the principal investigators and research staff.

This project was funded by the Ministry of Education under its Block Transfer Grant to OISE.

TRANSFER GRANT PROJECT OUPUTS

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Please list below under two separate headings, Actual Outputs and Anticipated Outputs. Please provide as much detail as possible including present status, e.g., mimeo for distribution, submitted for publication, etc. If you are not providing copies of actual outputs as appendices to your report, please provide one copy for filing in the OISE Library.

1. Description of Activities:

A. Project Description:

The effects of computers in education, as with other media, largely unanticipated by those who use them or propose their use (Lias, 1982). However, these initially unexpected outcomes, or side effects, later become expected outcomes as our experience alters our perceptions. The main purpose of this study has been to initiate and/or accelerate the process by which we identify and utilize the possible classroom effects of computers in education.

The project "Toward a Taxonomy of Possible Computer Effects in Elementary Classrooms" was funded during 1988-1989, May 1, 1988 to June 30, 1989. The project was located in an elementary school in a local Roman Catholic Separate School Board. A minimum of three and a maximum of six ICON computers had been placed in each classroom of the school by the Board of Education. Our research interest was in documenting any changes in classroom activity (teachers and student activity) or changes in school functioning which occurred subsequent to the computer application. We were intent on both the expected outcomes of the Board-initiated pilot project at the school as well as the unanticipated side-effects of computer use in the school.

The methodology was naturalistic and included observations in classrooms, extended interviews with teachers and students, and the collection of documents from the classrooms and the school.

The research project generated several paper presentations at conferences by Dr. R.G. Ragsdale, Dr. A. Brian Durell, and Dr. Alison I. Griffith (see Appendices). Mary Damianakis is completing her Master's Thesis based on project data. Dr. Ragsdale presented Ms. Damianakis' initial findings, as well as the initial formulations of project results to the teachers and administrators of the school. Further analyses of the data will be presented to the Board, the pilot school staff, and at international and national conferences in Boston, Mass., Victoria, B.C., Sydney, Australia, and San Francisco.

B. Revised statement of objectives (January, 1988 - June, 1989):

1. Budget Reduction: The research proposal had asked for 1.5 Research Officers to assist the Principal Investigators in mapping the computer-oriented activities in the school. The funded proposal included funding for one full time Research Officer. The fieldwork component was consequently reduced to accommodate the reduced funding level.

2. Extended Observations: It was decided to place observers in 10 classrooms (Senior Kindergarten to Grade 8). Observers (two Principal Investigators, two part-time Research Officers and one part-time Research Officer from another OISE project) observed classroom activity one-half day per week during the school year. In particular, we focused on the pedagogical character of the classroom and the activity of teachers and students in relation to the classroom computers.

3. Intensive Observations: A graduate student working with Dr. Ron Ragsdale conducted 20 days of intensive observations in four classrooms, and conducted 100 interviews with Grade 3 and 4 students during June, 1988.

4. Interviews:

   a. Interviews were done with students in the primary grades as well as with students in Grade 7 and 8. The interviews concentrated on student knowledge and reasoning in relation to computer software programs.

   b. Those teachers who had had observers in their classrooms for the year were interviewed in order to discover the professional intentions which underpin their classroom practice.

   c. Comparisons with other schools: The Principal Investigators visited other schools with well-developed computer resources in the Metropolitan Toronto area, three elementary schools and one secondary school in order to collect comparative data.

   d. Project findings were presented at professional days to teachers and administrative staff as a method of assisting formative evaluation within the school and within teachers' classroom practice.

2. Major Findings and Conclusions:

The project completed its observations, interviews and document collection in June, 1989. Analysis of the data is currently underway and will continue into Fall, 1989. The Master's Thesis by Mary Damianakis is almost completed and will be submitted for Fall Convocation. The papers presented to conferences represent our initial findings of the project and have been included in the Appendices.

The initial findings of the project are included in this section as the summary observational reports done by the four observers. Further analysis will continue over the summer allowing us to develop the similarities and differences between the classrooms. [Note that fictitious names are used in these observational reports.]

A. Observer 1:

I am planning to use the "Parable of the Sower" as the organizing framework of some of my writing about the project. The parable goes as follows:

> The sower went out to sow his seed. As he sowed some seed fell by the wayside. It was trampled upon and the birds of the heavens devoured it. Other seed fell on rocky ground where it grew up and withered because there was no moisture. Other seed fell in the middle of thorns and the thorns grew up along with it and choked the life out of it. Other seed fell into good ground and it produced a crop a hundredfold.

The computer applications were sown in the school. Some of the seed fell by the wayside, in that some teachers chose to ignore them almost entirely. Some of the computer applications were sown in "shallow enthusiasm", but without any real planning, so they died from lack of solid soil. Other computer applications died from the competition of other activities, both on and off the computers. Other applications were sown into healthy soil of planning and integration, producing useful crops (if not yet a hundredfold).

I am using "computer applications" rather than computers in order to make the links more general, allowing for a variety of out- comes in one classroom. The seed by the wayside is probably the easiest one to deal with, with some of the teachers we didn't include in our observation being almost totally "wayside".

The "rocky ground" is more interesting, being seen in those teachers who encourage the use of computers and don't get directly involved, but also in the applications that are assigned by the teacher but never followed up (Bar Graphs in one class is an example). "Rocky ground" is probably the dominant theme of most innovations, with people abandoning their implementations when the "implementation dip" strikes.

I see at least three types of thorns rising up to crowd out the useful applications. One is the competition within the students, as they choose entertaining programs instead of the ones that have been recommended or assigned. A second is from the teacher, as (according to Mary's report) they assign other activities and reduce computer time as the end of the year approaches. A third is from the system itself, the hardware and software failures that drive students away from useful work.

In considering the "good ground" I think of Gay Beckwith's comment about wanting to work with the teachers for a year before introducing the computers. This can be interpreted as "preparing the soil" for planting the computer applications. As the years have gone by, we have seen some changes in the soil, with one good example being the teachers who had the computers at home last summer. Another example would be a grade 5 teacher who began to use StoryMate only last month. One component of the good soil has been the patience of the principal in allowing people to move at a slow pace (not always as slow as they would like) of implementation.

B. Observer 2:

Studies on creativity abound. There have been studies done on the teachability of creativity (Torrance, 1972), the nature and definition of creativity (Perkins, 1981, Koestler, 1964), the notion of a creative situation (Mackinnon, 1968), divergent thinking and creativity (Kogan & Pankove, 1974, Guildford, 1967) and the effectiveness of creativity training (Mansfield, Busse & Krepelka, 1978 and Rose & Lin, 1984).

The Ministry of Education places a special emphasis on creativity and computers. The Policy/Program Memorandum, No. 47, February 1982, entitled "Computers in Education" states:

> There will be two fundamentally different ways to use computers in the process of teaching and learning. The more significant way will be the creative use of the computer by individuals: writing, composing, designing, analyzing, and other extensions of original thought. All students must be given opportunities to use computers in this way.

However, ethnographic studies that attempt to understand the everyday world of the classroom and relate it to creativity are few and far between (Henry, J. 1976 and Henry, J., 1957). The study by H. Carmichael entitled "Computers, Children and Classrooms: A Multi-site Evaluation of the Creative Use of Microcomputers by Elementary School Children" does attempt to show how computers were used creatively in classrooms but her study was multi-site and not an ethnographic, in-depth analysis of one situation.

When I commenced research in the two classrooms I was assigned in the school, my focus was not yet developed. The two teachers that I was observing were both male and both very experienced with computers, but their teaching styles were worlds apart. One was child-centered, discovery approach based and relaxed in his teaching style - the other was structured, well-planned, organized and classroom routine was exact and precise. Naturally their approach to computers were widely different. I became interested in the different kinds of work produced by the students in the two classrooms and it seemed to me that an in-depth analysis of the two rooms would provide valuable insights into how classroom culture can affect student output. It is with this light that I would like to divide my study into three parts: the

world view of the teacher, the culture of the classroom and the personal constructs of the students. I will now present some of the kinds of findings I collected. I will refer to the two teachers as Teacher A and Teacher B and their classes as Class A and Class B.

Teacher A once said to me:

> The world is changing and it is more important to have students learn to think for themselves. When I was at school, they thought they knew what kind of world I would have to face, so they taught me in that way. But now we know that the world is going to change: it is much more important that students learn to learn." He then went on to say that he couldn't teach to text and have the same set questions for everyone. It would be easier for him but what would it achieve? It was much more difficult to monitor what was going on with each child with the way he taught but he preferred it this way.

His classroom reflected this approach. The students were allowed to explore and discover new territory, but with direction from him. My fieldnotes for February 20th will illustrate this:

> 9:30 a.m. Teacher A says: "Ideas: here is one idea I want you to explore - adding fractions." He then goes onto explain that he wants students to challenge each other - he describes incident of when Mike was doing fractions, he knew that what his partner was suggesting was wrong - yet he did not challenge him. Teacher A says he wants students to challenge each other and if they cannot find the answer within one group to go to the next. He then gives them an idea to follow up on. They should make cards. He asks them what kinds of cards they would need to play the games. He draws some examples on the boards. Someone says picture cards - he draws picture cards and says another way would be put in numerals. After giving 5 examples , he asks the class to get started.
>
> 9:32 a.m. Teacher A is moving around. The girls in group 1 are playing a game with the equivalency fractions. Teacher A comes around and says there is a problem - he gets pen and paper and proceeds to show them. He says: "You know how to add like denominators but how would you add denominators that were not like. " He spends several minutes showing them, then asks them to incorporate how to change denominators into the rules of the game. He says: "Think hard - I'm really making you think hard now."

Students in Class A had varied kinds of responses to the atmosphere of the class. In a short report as this, it is impossible to give more than one example.

> Jason's work particularly impressed me. In an interview I had with him, he described the project he was currently working on. He was writing an adventure story using LOGO - he was programming it himself, using the text feature of LOGO, and also the graphics. The plot of the story was not very original - 4 children are in search of a crystal and in order to reach it, they must pass through all kinds of tribulations. What impressed me was his ability to design procedures in LOGO that would respond to the user's input. When I asked him if he learnt things on his own, he said: "Yes sometimes, how to do procedures, how to make the turtle do certain things - some of the things I read, some of the things I learnt from Mr. A." This student went to describe to me advanced features of Watfile, the differences between IPaint 1 and IPaint 2, how to animate in IPaint, how to make objects move away from you in animations. He then told me that at the end of the year, his personal space would be wiped out and he would lose everything he had done on his adventure story. He then said he was going to print everything out and re-produce everything on his computer at home. He had a C-64 at home - I asked him if he had LOGO and he said no, he had BASIC which he did not know but he was going to learn from the manual and then proceed to program his adventure story over the summer.

Of course this student far out-shone the others in the type of work he did on the computer, but I was also very interested in other students - of a different gender and of different ability levels, and their interviews and materials should produce more insight.

Teacher B had a very different approach to teaching. He was in the midst of real soul-searching and was re-thinking his entire approach to teaching. He once said to me:

> You see I come from a teacher-centered background where it's teacher-directed, and that's the kind of attitude that I brought to teaching when I started teaching. I thought there was nothing wrong with that and I still think that there is some place for the teacher direction. I like (child-centered) because ... I don't know everything and the kids, the students can teach me - if I think I know everything, then I can't learn

> anything. And I think child-centered helps me to understand that . I like to do what they are calling child-centered learning where I am becoming the facilitator - saying here is what I want you to do, it doesn't matter how you do it but you figure out what's the best means for you to meet that end.

The classroom atmosphere was very different in Teacher B's room. He had a definite culture and language: students knew what he meant when he said "GO!" or "S.Q.U.I.R.T" - students had to date all their work to him, and the date could only be written in two styles. Students often worked with assignments that he produced on pink, blue, yellow sheets where they answered specific questions. Projects were given with detailed directions - students knew exactly the kind of end-product the teacher was interested in. Some field-notes will illustrate what I mean:

> Jan 30th, 9 a.m.-- Students have an assignment sheet in front of them. Teacher B calls upon 4 students to go up to the board, and write the answers to the problems on the sheets. Teacher B is collecting money for something. After a few minutes he asks students to get out their math books so that they can begin work on the problems on the board. He asks the first student to go up and explain what he has on the board. The student goes up and works step by step through the problem which is calculate the average of several numbers. The teacher then asks him what his concluding sentence would be. He continues to ask other students what their concluding sentence was. The second student goes up and explains her problem. She has forgotten to put the addition sign and she places it on the board when prompted by the teacher."Is that the best place for it?", the teacher asks and has her change it. Another student explains where one should put the addition sign in different circumstances. Two girls have done their divisions differently - one in the long and the other in the short form - the teacher asks which one is better - the students say both are the same. He agrees.

One can see that the kinds of activity carried out in Math in both classes is very different.

Most of the work produced by the students in Class B tended to be of the nature where they produced good copy reports on the computer using word-processing programs. They used IPaint for illustrations for their reports too. They used it to produce their poetry booklets. Each week students have a spelling test that they produce on the computer:

> Each week students submit two words that they have looked up to a secretary appointed by each group in the class. The secretary types up the words into the computer on Monday during recess and the teacher dictates them on Tuesday and then gives back the typed- up pre-test. Students check their spelling against the print-out and correct the spelling for other students.

One use of LOGO by the class, I felt was interesting in that it contrasted a great deal with the student described above in Teacher A's class. In a conversation Teacher B describes to me what they did:

> Like for LOGO, when we did the LOGO scary stories for Halloween, I set up a generic program and all they (the students) had to do was go in and edit it and put in their story so they didn't have to learn any programming or anything and for that we used the large monitor - I just showed them, here's what is going to happen .. and all you do is to erase this line where it says here is where you write your story, and you write your story there, and then you just press Ctrl-C and you're out.

When I asked Teacher B if his students knew they were using LOGO he said:

> No, I don't really think that they were aware that they were using a programming language - that they were actually programming - all the programming had been done for them, but they were actually creating their own program because when you typed in the word Natasha, up came Natasha's "Choose Your Own Adventure Story". Um, some students wanted to know how it worked and I took them aside and I tried to explain it to them in the short time that I had but most students were just happy to know that when they pressed this key, their story would be shown on the screen.

Conclusions:

Teacher A and Teacher B certainly had very varied teaching styles and their students produced work that in some ways reflected their teachers. However, the issues were not so clear-cut: I observed many instances of students being ill- suited to the class they were in, I saw instances of both teachers being very authoritarian and also instances of teachers being facilitators for students' as explorers. I feel that the four

months that I spent in this school observing the two teachers will yield important information about how creativity can be fostered and what limitations it faces in the everyday world of the classroom.

C. Observer 3:

In the 1988-89 school year, I observed computer use in the classrooms on fourteen days. Most of my observations were done in a Grade 2 classroom and a Grade 7 classroom, although I also observed in other classrooms in the fall of 1988. On most observation days I spent the morning in one classroom and the afternoon in the other.

The aim of this observation activity was to determine how teachers and students were making sense of and using the computers that were in their classrooms. This was accomplished largely through observation of classroom activities, particularly those involving the computers. Informal interviews with teachers and students and examination of classroom materials and student products provided further information. In the latter stages of the observations, a laptop computer was used to record field notes. This reduced the need for transcription of notes following observation periods and, I believe, improved the quality of the record of classroom activity.

OBSERVATIONS:

Observations will be presented in terms of particularly salient features: placement of computers in the classroom, the teacher and the computers, the students and the computers, and curricular use of the computers. Most of my comments will be based on the grade 2 and grade 7 rooms where I spent most of my time with supplemental observations based on experience in other classrooms.

Placement of computers in the classroom:

The grade 2 teacher located the three computers in a back corner of this room. The workstations and printer formed a small 'L' shape with two computers along the back wall and the third computer and printer located on a side wall of the classroom. A small bookcase partially separated the computers from the rest of the classroom. Physically and, as we shall see, functionally, the computers were not central in the operation of this classroom.

In the grade 7 room, the six computers were arranged in a line along the window wall of the classroom. While physically off to the side of the room, due to their numbers and the ways in which they were used, the computers were a more integral part of this classroom.

Back corner and down the wall arrangements were seen in other classrooms as well, but they were not the only locations for computers in this school. While all teachers clustered the computers together, some formed them into squares. One teacher arranged six computers in a 'T.' The students using these computers were effectively isolated from one another by the way in which the screens of the machines were turned. Another teacher rendered the computers very difficult to use by placing them in the back corner of the room and turning the computer screens toward the wall. This meant that the students had to squeeze in between the wall and the table supporting the computers in order to use them. This cut down on other students looking at the work of the students using the computers. It also made it very difficult for researchers to see what was happening on the computer screens.

The teacher and the computers:

The grade 2 teacher showed no signs of liking computers. He made disparaging remarks about their reliability and seemed almost pleased when he could report that the system was not available on a given school day. However, he did not prevent students from using the machines. This teacher had a very structured approach to the operation of his class. He began each segment of the school day with the class gathered around him for instructions. Language arts work always followed the morning instructions.

During this time he would often have students use the computers for their writing. When the computers were in use, the teacher would move about the classroom checking on and discussing the work of individual students. He would allocate proportional time to the children using the computers. He checked their work regularly.

When problems arose with the computers or the printer, this teacher would respond to calls for assistance. However, he knew little about the computers and usually could not do much to correct problems. His standard way of dealing with a malfunctioning computer was to turn it off and on, hoping that it would perform correctly if restarted.

The grade 7 teacher also had a definite order of subject matter and procedures for each school day. A schedule posted on one wall showed the subject topics for each time period throughout the week. However, the exact procedures followed during any subject matter time slot were less rigid and predictable than the procedures seen in the grade two classroom.

The grade seven students used the computers more than the grade two students did. This was not simply a factor of having twice as many computers in the classroom. In the grade seven room, the teacher assigned specific tasks to be completed using the computers. These assignments were handed in for grading. It is important to note that most of the students wanted to use the computers. Only one student chose to complete all school work for the year without using computers. A few others would give up their computer time now and then.

In the grade seven class, the teacher had moved away from a rigid "it's time for you to use the computers now" approach. Rigid scheduling of that type was common during the first year of computer use in the school. Many teachers carried on with a strict timetable for student use of computers. This grade seven teacher was among those who were starting to have students show why they wanted to use the computers before permission was granted.

The grade seven teacher monitored the use of the computers by students. She experienced fewer calls for help than did the grade two teacher. She also spent a proportionally smaller amount of her time checking the work of students at the computers. This may have been because she was expecting students to hand in print-outs of what they had accomplished so she would have that indirect indication of how effectively the machines had been used. One grade eight teacher never approached students while they were using the computers. However, she had the students place the work that they produced on the computers into a folder. She did check these folders regularly. Thus she would get a sense of how much the computers were being used and also how well they were used.

<u>The students and the computers:</u>

Most of the students valued their time at the computers. One of the children in the grade two class was a discipline problem, but he enjoyed using the computers and requested extra time to use them. One student in the grade seven class preferred to write with a pencil and would give up her time on the computer. She was not forced to use computers.

Students showed a curious blend of expertise and ignorance as they used the computers. I saw many who were very proficient in navigating their way through the intricacies of word processing and the DRAW program. Yet the same students could show surprising inability with some aspects of the same programs. It was common to see primary students who could log onto the computer system, type their text, and print it with the flourish of professionals. Yet those same students did not realize that they could just keep typing when they came to the end of a line -- the program would wrap the text around to the next line. Most students at the primary level would position the cursor manually at the beginning of each line with the trackball. A few intermediate students would do this, too. Clearly, this points to a lack of instruction in the mechanics of the programs and an inadequate model of the process of writing with a computer. I will return to these points in the conclusion of this report.

There was a strong tendency for students at both the primary and intermediate level to interpret instructional programs as games. The students seemed to be task oriented in the sense that they felt it was important to work their way through programs as quickly as possible. This meant that they often did not read instructions carefully or attend to informative feedback as they worked through programs. They did not seem to expect to learn from the programs, but regarded the programs merely as tasks to be completed.

Not all computer use was purposeful. Some of the grade seven students seemed to 'hide' at the computers. They would sign on, but produce little or nothing. An inordinate amount of time would taken up with the sign on process. Then producing a few lines of text would take half an hour. At the end of that time, the bit of text produced might be abandoned. It seemed that these students knew that the teacher did not check work being done at the computers very closely. This made it fairly easy to fake activity and thus fill out a substantial amount of time with a minimum of effort. At times, students took playful approaches to programs, even those that were tools such as the word processors. Some students would investigate the limitations of the programs by doing strange things with them. For instance, some students would combine rapid key-striking with spinning the trackball. This would produce a screen full of more or less randomly placed letters in a somewhat artistic pattern on the screen. This type of activity was much more common among the boys than the girls. Most of the girls were task oriented in the sense of trying hard to have a product to show at the end of a session on the computers. Many of the boys were more inclined to explore what the programs could and could not do. They were not disturbed if they had no picture or text as a result of their computer use. It is difficult to come to the conclusion that the girls were, in an ultimate sense, making better use of the computers than the boys.

Curricular use of computers:

In this, the second year of the computer project in this school, there was much more effort on the part of the teachers to relate computer use to the curriculum. The easiest way to achieve that end was to use the computers for writing. Both the grade two teacher and the grade seven teacher did this. As noted, the grade two teacher seemed less concerned that student work be written using the computers, but he still provided the opportunity for the children to write on the computers and submit their printed text to him if they wished to. In grade seven it was expected that a substantial amount of the curriculum related writing would be done with the computers. In April, I saw a display of student writing on the bulletin board in the grade seven class room. One of the book reviews appeared to be typed -- all the others looked like they had been produced on a printer.

Students in both classes used a graphics program called DRAW. The grade two children tended to produce pictures related to themes in the year -- Halloween, snow scenes. Students in grade seven produced pictures to illustrate or serve as cover pages for themes that they were writing such as a project related to North American Indians.

The grade two teacher, in common with other primary teachers in the school, used arithmetic drill programs. The grade seven teacher centred computer use almost entirely on tool type programs.

CONCLUSIONS:

Integration of computers into a school is much more complex than the mere introduction of the hardware. Much time is needed for teachers and students to become familiar and comfortable with the software and the hardware. In the school studied, after two and a half years, the teachers are still not completely familiar with the software. Mastery of the software is a growing concern among them. In their busy schedules they have not had sufficient opportunity to try out a range of programs and consider how they might be used in the classroom. This is not indicative of sloth on the part of the teachers. Rather, it indicates how busy teachers are with their regular duties and how long it takes to build mental models of what computers do and how they might affect a teacher's classroom practice. It was clear that the teachers are having students use programs with minimal or no instruction. This apparent negligence is

merely an indication of the lack of time that teachers have to learn about the machines themselves and to fit them into crowded classroom routines. Also, there is no computer lab in the school. A room with a computer for each student could be very effective in introducing students to new software, but only after teachers have a chance to become familiar with the software themselves. Up to this time, students expect and get most help with programs from other students. Teachers either are not available when needed or know less about the programs than the computer- keen students. This condition will change with time for teacher learning, but it is likely that student to student instruction will remain important in any computerized classroom.

Teachers cannot spend all of their time with the students using the computers. However, it is important that they spend as much time as possible with them. The research team has seen many instances when students have had difficulty with a concept in a computer lesson or with some aspect of operating a computer program. These teachable moments are crucial for increasing student understanding. Although it was our intention to be objective observers, all of the researchers on the project have, from time to time, intervened to show students how to make a program work or how to operate the hardware more effectively. This also is a matter which teachers certainly will handle better as they become more familiar with the system.

There is much evidence that there are major mental accommodations to be made by both teachers and students as they use computers. We do not simply replace pencil and paper ways of doing things with electronic equivalents. This is shown in the way that primary and a few intermediate students use word processors. The idea of pressing keys to form letters is absorbed quite quickly. However, students extrapolate from their prior experience with pencil and paper, or from experience using typewriters, and expect to have to position the cursor for the next line of text just as they would have to position their hands or the print ball on a typewriter. So we see them using a trackball to put the cursor on the next line of text. It will take instruction and experience for them to understand that a word processor brings the ability for one just to keep typing and that the machine will take care of positioning automatically. This is just a small symptom of the sorts of mental adjustments that must be made as this powerful machinery is introduced into the learning environment.

We have learned much about what happens when computers are put into classrooms in significant numbers. Much more remains to be discovered. The further stages of teacher development should be studied carefully as teachers will almost surely move to higher levels of computer use. It is also important to monitor the cognitive development of the students. The worlds of both major actors in classrooms are changed in major ways when computers are introduced. So far we are only discovering some of the changes that are wrought. More such cataloguing needs to be done. Then the significance of the changes need to be assessed and evaluated.

D. Observer 4:

Description of Classrooms:

The two classrooms in which I observed were primary level classrooms with between 29 and 30 students. The classrooms are portable classrooms. There are no sinks; no rugs on the floor; the temperature of the classroom is difficult to regulate; the children's coats and boots are inside the classroom, usually next to the computer; the floors, desks and computers are difficult, if not impossible to keep clean; often, the tables used by the students have no place to keep papers and books so they stay on top of the table. The problems of dirt, inadequate furnishings (including no or inadequate window coverings), and inadequate classroom resources are present at all times during the year and are part of the schooling experience for both teachers and students.

The two teachers had very different teaching styles. There is some indication in the data that the more chaotic teaching environment of Ms. Arcona contributed to the development of some children's creative abilities while the more structured teaching environment of Ms. Baker developed students skilled in

working cooperatively but not necessarily creatively.

Ms. Arcona stressed independence, creativity and child- centred learning. She alternated between structured lessons when new material was presented and desk work individually or in groups. Her classroom was very noisy -- often the children would be talking or playing while Ms. Arcona worked with individual students on their assignments. My initial impression of chaotic disorganization shifted as I began to see the work organization of the classroom and the actual work that most of the students were accomplishing. Ms. Arcona is a skilled teacher and is capable of moving some of her students through an impressive amount of work during the school day. For those students who work well in an environment in which a lot is happening all the time, the classroom experience is good. For those students who do not work well in this type of classroom setting, the experience is certainly not as useful.

Ms. Baker's teaching style is very different from Ms. Arcona's. Ms. Baker's classroom is also child-centred but certainly not to the extent of Ms. Arcona's. Ms. Baker stresses independence, cooperative working processes, and good work habits. Her classroom is usually quite quiet as the children move from group lessons to group and paired curriculum assignments. Ms. Baker is a skilled teacher and her students are able to complete fairly complex research projects even at the primary level. Some of her students are very skilled at story writing but those same students did not seem able to extend their creativity to other areas of the curriculum.

The computer areas of the two classrooms were very different, as well. In Ms. Baker's classroom:

> -Computer area: There are two computers facing the back wall and one facing the classroom area. The printer is at the end of the table closest to the classroom area and is available to all computer users. Over the computers hangs a mobile-type sign labelled "Computer Activities". From that sign hangs drawings with explanatory notes suggesting computer activities the students can do while there. Today the activities were pictures of robots (very like the Tin Man in the Wizard of Oz) with instructions such as "Use Draw to create a computer title page for a science project." "Try your skill with Hangman spelling or Add... math." "Use draw to illustrate a poem or short story." As well, there is a set of instructions on how to log onto the computer and get into programs.

Ms Arcona's 3 classroom computers were ranged across the back of the classroom facing the back wall. During the year, the computers were turned around to face the class. Ms. Arcona's computers were often down, a problem in the computer network of which her classroom is a part. As well, one of the computer wall plugs would not stay in the wall leading to computer failure at odd moments.

> Dominic goes over to help Franca and to help Shanyn. Shanyn has named her totem pole Shanyn Totem Pole. Dominic is helping Shanyn and then checks to see that she's saved it then takes over her machine after he exits the program for her. Franca won't let Dominic see what's on her screen. Franca saves it and exits and tries to print what she's done. Dominic: "The printer doesn't seem to be working. I hate these machines, they're so frustrating." Dominic is told by the teacher to check the plug in the wall. Teacher: "Do the totem pole and then put it in your personal space." Dominic: "Last time I put it in my personal space, it wouldn't stay there. And now its there again."

Unlike Ms. Baker's computer area which looks and operates as a learning centre, Ms. Arcona's computer area contains only the computers.

Computer Use in the Classroom:

The students in both classrooms used the computers fairly regularly. Both Ms. Arcona and Ms. Baker assigned student time on the computers. Students used both CAI and "tool" software.

Ms. Baker began the year with her students working in pairs within groups. She would pair a child who was moving through the curriculum quickly with one moving more slowly for both reading and for computer use. Each group had a day on the computer and pairs within the groups would use the computer for completing assignments using drawing or word processing programs, or would have time on the computer to explore the CAL programs such as Typeaway:

-Luigi and Kevin attracted to the printout done by Shannon and Melissa. "How do you get in there?" "How do you make a helicopter." Melissa: Its easy, it does it for you." Luigi: "How do you get in there." Shannon goes to Luigi and Kevin's computer to show them how to get into the program. Shannon: "You put your hands on the keyboard. Put your thumb on the spacebar. You hold your hands like this." Luigi insists on holding his hands in any way he wants to -- using two fingers to type.

Kevin wants his turn and wants to sit closer to the keyboard so he can put his hands on the keyboard properly. Shannon pulls the keyboard over to in front of him. Kevin starts out with his hands on keyboard as shown but soon is involved in finding the letters and forgets to hold his fingers as demonstrated. Shannon is still helping.

Shannon is working at her picture by keyboarding and trying to keep her hands on the board as asked for by the program. Luigi pressing SXS, SXS, etc. while Kevin presses the spacebar in between. Both using two fingers. B3 (Michael) comes over to Luigi and Kevin. Kevin: "What is the number for hockey?" Shannon and Melissa printing out Melissa's work. Luigi: "Lets just go to anything." Luigi, Kevin and B3: B3 starts to leave. Luigi and Kevin arguing over what to go to. "Lets just go to anything."

On the computers are some of Group 2: On C1 is Helen and Jeffrey; C2 is Luigi and Kevin; C3 is Melissa. The students are all logged on to Draw. A question is asked about how to do the exercise. Teacher:"You estimate first and then you measure them." The computer group is drawing lines, estimating their length in cm and then measuring them. One partner draws the straight line "any size you like but it has to be a straight line. Tell him when to stop Helen." Jeffrey has been drawing the straight lines and Helen has been sitting passively watching him. Teacher's comment is a way of having Helen participate in the drawing process. "Ms. Baker, Jeffrey already made a guess." "14 cm" Michael comes over to check out what's happening on the computers and then leaves. Now, Jeffrey is drawing the line and Helen is estimating. Teacher: "When you fill your page, print it and actually measure the lines." Teacher is working with Melissa on C3. Jeffrey: "Lets do it in different colours." Helen: "OK" They change the colours to red lines.

Ms. Baker also gave lessons which addressed the computer directly. For example, one unit concerned the use of computers in the community:

Wall display:
All About Computers
(This sign has been added to the "What makes a computer" board.)

Poster 1:
"Computers in the Community:
Library - The computer that checks out the books.
Bank - The alarm system. The Green Machine.
Police Department - The alarm system.
Airport."

Poster 2:
"Computers in more places:
Music - keyboards, electric guitars.
Sports - scoreboards, ski lifters.
Any other places? - coke machine, computer digital alarm, clock,
-telephone, new video games."

Poster 3:
"Computers in Hospitals and Health Care:
checking out, dialysis machine, file computers, digital scale, robot, ticket booth, pop machine, heart rate measurer."

Poster 4:
"Computers in the Community:
Supermarkets - cash register, bottle collector, weigh scale, coupon machine.
Gas stations - gas pump, cash register, carwash.
Restaurants - telephone, microwave, pop machine, coffee maker. Stores - cash register."

Later in the year, Ms. Baker changed her assignment protocols and allowed those students who were finished their work to use the computers in any way they wanted to. Consequently, those children who had the least difficulty with the curriculum spent more time on the computers than those who were slower at finishing their work. At the same time, Ms. Baker reduced her emphasis on computers and the computers were not in use to the same extent.

The computer use in Ms. Arcona's classroom was organized around individual use of the computer. Ms. Arcona would tell students when to go to the computer and when to leave. Often, the students would use the Draw program to draw pictures for inclusion in their books:

> Trudy has drawn a totem pole that looks like a Walt Disney tree -- faces in the tree and arms that look like they will swoop down and get you. Lenny is drawing a circle and putting ears on it. Franca is moving boxes around and filling them in with colours. Trudy: "Look at the cats eyeball. It starts out small and gets huge." [Draw program] Ms. A: "OK you three on the computer, back to [the menu screen] please."

> Three boys move to the computer. Teacher: "If you've done a totem pole, do what you want." Boy asks how to spell "junk" which is his login. B1 tells him how to spell it. B3=Chris -- goes to "Upstairs, Downstairs" (a primary level program for Senior Kindergarten and Grade 1) which has a house with happy faces. Teacher: "Did you guys just get on? Oh you can stay there till lunch. This afternoon ...." She names 3 boys who will be on the computer then.

Ms. Arcona maintained this kind of computer use throughout the observations.

Concluding Comments:

In both these classrooms, the computers were used as "tools" for word processing and drawing, and as a form of educational entertainment. The students in Ms. Baker's classroom used the computer in relation to curriculum- oriented tasks primarily. The CAI programs were those which would increase their keyboarding skills, their spelling and math skills and so on. Ms. Baker kept a close watch on the students' computer use, gave lessons which concerned the computer directly, and assigned computer tasks. Ms. Arcona emphasized individual use, assigned computer tasks primarily in Draw, and allowed the students to explore all the computer software on the file server.

There were several side effects or unanticipated consequences which evolved through the classroom computer use. The hardware problems encountered in Ms. Arcona's classroom produced a high level of frustration for both the teacher and the students. Computers came to be seen as unreliable for curriculum use when the students could not begin work assigned on the computer, could not complete their assigned work on the computer, or could not save the work they had done on the computer. This contributed to the sense of classroom computers as educational game sites. Ms. Arcona's emphasis on creative individual use of the computer meant that the students explored the variety of software programs on the file server, but explored them as games. Thus, the junior primary level programs such as "Putting Yourself

Together" were used in a game-like manner to make bizarre human figures. The possibilities of creative exploration were offset by the banalities of the games use.

In Ms. Baker's classroom, the side effects were less obvious. The relatively tighter monitoring of computer use meant that the games-like use of software was reduced. The use of computers in this classroom was more "tool" oriented and the lack of hardware problems meant that student work could be saved and hard copies of the work produced. At the same time, the assignment protocols adopted by Ms. Baker at the end of the year limited the access of some students to the computer. Those children who were slow at completing their curricular work had less access to computer time. If, as is claimed, computer facility is a skill required for participation in the "information society", slower children are accumulating disadvantage within this assignment process.

The different kinds of computer use in the two classrooms tells us about the place of computers in the classroom curriculum. Ms. Baker had taken control of the computers available to her, had selected programs for the file server, and assigned curriculum tasks that could be completed on the computer. Ms. Arcona did not exert much control over computer use in her classroom. In keeping with her emphasis on child-centred learning, her students were encouraged to exert some control over the classroom computer use. Within the classroom, they become a resource to be used in relation to the teacher's pedagogical goals. Any assessment of what is learned must be placed in the context of the classroom learning process, the teacher's pedagogical goals, and the capabilities of the children within the classroom culture.

Actual Outputs:

Ragsdale, R.G. (in press) The Implications of Computers for Teacher Development. Canadian Journal of Education. (appended)

Ragsdale, R.G. (1988) AI: Artificial Intelligence or Adaptive Idolatry? Paper presented at a Colloquium sponsored by the Department of Philosophy, Independent Studies and the Centre for Society, Technology and Values, University of Waterloo, November 25, 1988.

Durell, A.B. (1989) Teacher Adaptation to Computers in the Classroom. Proceedings of the Sixth Canadian Symposium on Instructional Technology, Halifax, May, 1989. (appended)

Durell, A.B. (1989) Bringing Computers into the Classroom: A Concerns Based Analysis. Presented at the Canadian Society for Studies in Education, Learned Societies Meetings, Quebec City, June 1989.

Griffith, A.I. (1989) Information / Automation: Computers and Contradiction in the Elementary Classroom. Proceedings of the Sixth Canadian Symposium on Instructional Technology, Halifax, May, 1989 (appended)

Griffith, A.I. (1989) Computers and the Change in Teacher's Work. Presented at the Canadian Society for Studies in Education, Learned Societies Meetings, Quebec City, June 1989.

Anticipated Outputs:

The research team is organizing a session at the American Educational Research Association Meetings in Boston, 1990, as well as a session at the Canadian Society for Studies in Education, Victoria, 1990. Dr. Ragsdale is presenting a paper based on the research at a conference in Iceland, June 1989, and Dr. Durell will be presenting some of our research findings at a conference in Melbourne, Australia in November, 1989.